



Marshall Space Flight Center Nonmetallic Materials

Engineering Solutions for Space Science and Exploration



Engineers installing SOFI spray guns



Technicians insulating a 24" solid rocket
motor case in 4707



4765 TPS Development Facility
Spray Booth

Nonmetallic Materials research, technology, and engineering support are core capabilities of Marshall Space Flight Center's (MSFC) Materials and Processes Laboratory.

The Laboratory develops nonmetallic materials, processes, and products to be used in space exploration application and manufacturing. Research and development is performed in the laboratory, field, and flight experiments. Laboratory personnel have a deep understanding of the technologies associated with cryogenic insulation, paints, primers, coatings, adhesives, seals, ablators, thermal vacuum testing, large scale thermal protection system processing capabilities, ceramics, in-space resource utilization (ISRU), solid rocket nozzles, solid rocket insulation, solid rocket propellant, and subscale solid rocket motor processing.

The Laboratory's Thermal Protection System (TPS) Development Facility was designed to develop environmentally compliant TPS materials and processes for current and future space programs. The facility provides the ability to apply both primers and spray on foam insulation (SOFI) materials to large-scale test articles in various orientations. Various TPS material characterization tests can also be performed by the Lab. Capabilities range from

low fidelity in-process tests such as density, plug pull, and reactivity testing to higher fidelity thermal vacuum tests that expose TPS materials to vacuum levels and heating rates that mimic a launch vehicle's ascent through the atmosphere and into space.

The Lab's involvement in nonmetallic includes subscale solid rocket motor material selection, testing, and processing. To deal with material obsolescence issues, the Laboratory investigates alternative materials for solid rocket motor applications. A material's ability to protect against the harsh, erosive solid rocket motor plume environments can be tested in the unique Plasma Torch Test Bed (PTTB). The Laboratory also manages manufacturing of subscale solid rocket motors that are used to validate material and process changes before being implemented on full-scale hardware.

The Laboratory has been heavily involved in a various nonmetallic research, development, applications, and testing. The Laboratory develops carbon-carbon, ceramic matrix composite, and TPS materials for a variety of applications from large-liquid rocket engines to winged hypersonic vehicles. Advanced ceramic fuel elements for nuclear thermal propulsion are also in development.

Capabilities

TPS Development Facility:

- 30- × 30- × 85-ft Class I Div. I rated (able to utilize flammable materials) temperature and humidity controlled spray booth with associated heating, ventilation, and air conditioning (HVAC) equipment. Provides:
 - 20- × 27- × 70-ft hardware capability.
 - Temperature limits of 65–130 °F
 - Temperature dependent relative humidity ranges of 5%–75%.
- 9-axis Fanuc M710iC 70 robotic system (with tower and track).
- Two-part foam dispense system along with a nitrogen drum pressurization capability.
- Portable new delivery system (PNDS) two-part foam dispense system for manual sprays.
- Heated test panel holder (capable of holding six 2- × 2-ft test panels).
- Horizontal process tooling, vertical process tooling, and an associated TPS transporter.
- Data acquisition and remote viewing capability.
- Onsite cold-storage coolers required for processing of HFC-245fa based cryoinsulation materials.

TPS Materials Testing:

- Pour foam testing capabilities with multiple foam molds available.
- Bonding lab with the ability to adhesively bond TPS materials.
- In-process testing including portable tensile (plug pull), density, and reactivity testing.
- FOAMAT foam reactivity test equipment.
- Machining equipment, cure ovens, and tooling for specimen preparation.
- Thermal Vacuum Test Facility:
 - Pressure profiling (0–10 mmHg).
 - Radiant heat profiling: Quartz lamps (90 kW) (20 Btu/ft²sec calorimeter sensors).
 - Data acquisition (50 scans/sec).

Subscale Solid Rocket Motor Processing and Manufacturing:

- Subscale motor processing area for laying up insulation and motor assembly tasks.
- PTTB is an internationally unique ablation test bed that offers reliable, statistically proven data at a fraction of the cost of subscale motors or other test beds. The PTTB successfully simulates mission environments via high-temperature plasma jets that provide thermal and erosive testing of flight materials and screening of new materials.

Carbon-Carbon, Ceramic Matrix Composite, and TPS Materials Development

- Various ovens and furnaces (capable of 760-1,700 °C operating temperatures).
- Astro high-temperature furnace (2,500 °C, 4-in diameter × 6-in hot zone).
- Ajax toccu induction furnace facility (2,600 °C, 2.8-in diameter × 6-in hot zone).



Technician manually applying SOFI



Insulating cryogenic tank used for vibration and acoustic



Engineers with a 24" Solid Rocket Torch Motor (SRTM)

Key Benefits

- > Unique combination of facilities and experience
- > Advanced research capabilities

For more information, please visit www.nasa.gov/centers/marshall/about/business.html

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